



## This is where the eagle sits

Look who stepped out of the Great Seal to wear a CMC Crusading Engineers' medal. Think he looks proud? You should see us! **He's on the first and only solid-state counter fully militarized to meet Mil Specs.**

If you want the safety of a counter providing full Mil Specs reliability at a price surprisingly close to a commercial counter, then check these specs: 0 to 100 Mc frequency range; oscillator stability of 1 part in  $10^9$ ; meets or exceeds MIL-E-16400, including appropriate temperature, humidity, vibration, shock, and RFI

specs; built-in time interval measurement. Three militarized plug-ins available: 500 Mc heterodyne converter, 3 Gc heterodyne, and a 15 Gc transfer oscillator.

It may take some time, but you can probably expect copies of this counter from our creative competition at high-powered H-P and big, bad B. But they'll be copying the instrument



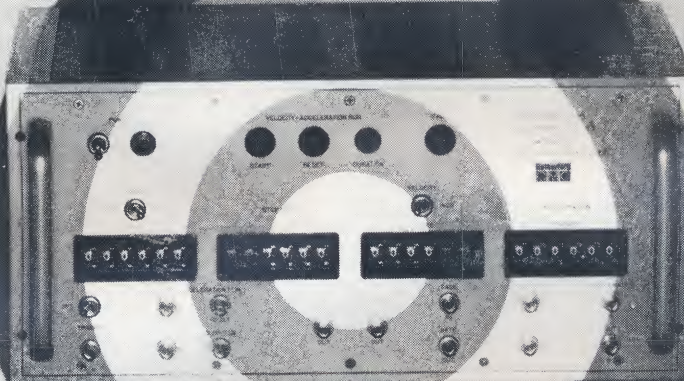
originated and designed by CMC. State-of-the-art development of a fully militarized solid-state counter isn't the first or last technological coup for CMC. Add to it the first all solid-state counter, first all-silicon solid-state counter, first 10-line-per-second low-cost printer, first dual plug-in counter, and numerous others.

Write today for a complete spec sheet on our new Model 880 so you can compare when and if the others arrive on the market. And remember, we won't give you the bird, we'll give you a medal.

12976 Bradley • San Fernando, California • Phone (213) 367-2161 • TWX 213-764-5993

COMPUTER MEASUREMENTS COMPANY IS A LEADING DESIGNER AND MANUFACTURER OF ELECTRONIC INSTRUMENTATION TO COUNT, MEASURE, AND CONTROL.





# We make enemies

Simulated enemies are available in a compact package labeled the RUTHERFORD S1 Dynamic Range Simulator. It is the most accurate, reliable, stable video target simulator ever developed. With it you can evaluate, check, and calibrate range, range rate, target tracking, and tracking memory of the most sophisticated weapons control and tracking systems. Forget the limitations and problems built into old-fashioned analog simulators.

Check these parameters: Target Range in one-foot increments from 0 to 1 million feet. Target Velocity

from 0 to 100,000 ft/sec in 0.1 ft/sec increments. Target Acceleration from 0 to 10,000 ft/sec/sec with 0.01 ft/sec/sec resolution. Check all the specs. They meet or exceed the rigid performance requirements of any known weapons control system or tracking system used for air traffic control, satellite surveillance, etc. The Rutherford S1 is an example of

the advanced design that has established Rutherford as the leader in pulse and time delay instrumentation. Other sophisticated instruments will soon be developed by the new CMC/Rutherford team. Our intent is to give you a wide range of instruments that are always the best quality and best buy.

So join the Rutherford Rampage (a division of the CMC Crusade) and write today for the complete specs on the S1. Learn how you can earn your own glorious Crusading Engineers medal with special Rutherford stripe. You'll look so handsome!



12982 Bradley • San Fernando, California • Phone (213) 772-6321 • TWX 213-647-5170

THE RUTHERFORD DIVISION OF CMC IS A LEADING DESIGNER AND MANUFACTURER OF PULSE GENERATORS, TIME DELAY GENERATORS, AND DYNAMIC RANGE SIMULATORS.



# Check these specs for something new



See it? We've got a new battlefield ally. Rutherford Electronics... the nation's number one name in pulse and time delay instrumentation... has joined our crusade as a division of CMC. What a way to finesse big, bad Beckman. (Poor guys, they don't even make a line of pulse generators or time delay generators.) And how about that for keeping our promise to compete with high-powered H-P right up and down their full line! OK, so this is sort of a sneaky way to outdo those guys. But we warned

everybody that we were "hot", and on a crusade to shake up our competition in the instrument business. Now, with Rutherford at our side, we'll be creating some great new instrument improvements for you. Just wait and see what happens when we apply our combined digital and pulse circuitry know-how.



So, Crusading Engineers, look sharp! Look twice! Now we double-dare you to "check the specs". Check the specs of CMC counters and digital printers... AND, check the specs of our Rutherford division's great line of pulse generators, time delay generators, and the new dynamic range simulator. We honestly believe that spec-for-spec, you won't be able to beat CMC/Rutherford instruments for the money anywhere. Write us! You'll double your sure, and earn a glorious Crusader engineer medal, too.

12975 Bradley • San Fernando, California • Phone (213) 772-6321 • TWX 213-647-5170





## MODEL 633A TIME INTERVAL METER



- CONVERTS 225 Mc FREQUENCY METER INTO A MULTI PURPOSE COUNTER-TIMER.
- TIME INTERVAL MEASUREMENT FROM 1 MICROSECOND TO 10 SECONDS WITH MODEL 616A FREQUENCY METER.
- HIGH SENSITIVITY.
- ALL SOLID-STATE CIRCUITRY.
- TWO YEAR WARRANTY.

### CHARACTERISTICS AND APPLICATIONS

The CMC Model 633A Time Interval Meter is a plug-in electronic module designed to be installed in the center compartment of the Model 616A Frequency Meter to measure time interval between two electrical events. The combined instrument measures the time interval between two points on the same or different waveforms with measurement results displayed in microseconds. Typical uses include digital measurement of range, using sonar or radar technique, as well as digital measurement of ballistics speeds, shock wave travel time, pulse widths, rise times and repetition intervals.

### OPERATING ADVANTAGES

Calibrated trigger level and attenuator controls with slope controls for start and stop inputs permit selection of any desired points on the input waveforms for triggering. Marker

waveforms are available at a front panel receptacle so that the trigger points can be observed on an oscilloscope.

### DESIGN AND CONSTRUCTION

The Time Interval Meter mounts in a rectangular opening in the front panel of the Model 616A Frequency Meter. Electrical Power and circuit interconnections to the counter assembly are supplied through a mating connector. The module is secured by a single thumbscrew, making installation and removal simple and rapid.

### WARRANTY

CMC, with ten years of specialized experience in the design and manufacture of high quality electronic instruments, backs each Model 633A Time Interval Meter with a two year free service warranty.

### MODEL 633A SPECIFICATIONS

RANGE: 1 microsecond to 10 seconds.

CLOCK FREQUENCY COUNTED: 1 mc.\*

READS IN: Microseconds.

RESOLUTION: 1 microsecond.\*

START AND STOP: Separate channels. Start input can be connected to both start and stop channels by a front panel switch.

ACCURACY:  $\pm 1$  count  $\pm$  oscillator stability  $\pm$  trigger level error.\*\*

INPUT SENSITIVITY: 100 mv rms.

MAXIMUM SIGNAL INPUT: 500 volts peak, each channel.

INPUT IMPEDANCE: Approximately 1 megohm shunted by 80 pf.

INPUT FREQUENCY RANGE: Dc coupling (start and stop channels), 0 to 5 mc. Ac coupling (start and stop channels), 10 cps to 5 mc.

INPUT ATTENUATION FACTORS: 1, 10 and 100.

INPUT TRIGGER SLOPE: Positive or negative, selected independently for each channel.

INPUT TRIGGER LEVEL: Continuously variable from +1.0 volt to -1.0 volt multiplied by attenuation factor; separate control for each channel.

OUTPUT MARKER: Output pulses of approximately 1.5 microsecond duration and 10 volts peak for oscilloscope intensity modulation to indicate start and stop trigger points on input waveform.

MOUNTING: Plugs into front panel compartment of Model 616A Frequency Meter.

WEIGHT: Approximately 5 pounds.

PRICE:

\$325.00

\*OPTION 11:

\$100.00

0.1 microsecond resolution. (10 mc counted)

\*\*Trigger level error = 0.3% of reading with 100 mv rms sine wave input at 40 db signal-to-noise ratio.





# MODEL 616A FREQUENCY METER



Model 616A Frequency Meter, with Model 634D Frequency Converter Installed.



# MODEL 616A FREQUENCY METER

■ DIRECT FREQUENCY MEASUREMENT FROM 10 cps to 225 mc. ■ ALL SILICON CIRCUIT RELIABILITY; WIDE OPERATING TEMPERATURE RANGE. ■ EASIEST COUNTER TO OPERATE; COMPACT DIMENSIONS; CONSERVES BENCH SPACE; "BRIEF CASE" PORTABILITY. ■ EXPANDABLE MEASUREMENT FUNCTIONS WITH PLUG-IN CONVERTERS. ■ 7 DECADE IN-LINE DISPLAY (8TH DECADE OPTIONAL). ■ TWO-YEAR WARRANTY.

## CHARACTERISTICS AND APPLICATIONS

The CMC Model 616A Frequency Meter is a general purpose electronic counter designed for rapid, accurate measurement and direct display of frequencies in the range 10 cps to 225 mc. Its compact size, sturdy construction and exceptional ease of operation make it an ideal instrument for general laboratory use and for field applications. All silicon semiconductor circuitry, plus conservative electrical and mechanical design, assure continuously dependable operation in varied environments and over wide temperature ranges.

Typical applications of the Model 616A Frequency Meter include: calibration of high frequency signal generators and communications equipment; direct monitoring of radio and television transmitter carrier frequencies; oscillator frequency drift measurements; telemetry and telephony subcarrier frequency measurements; spectrum analyzer calibration; audio frequency measurements.

Frequency extender plug-ins available to mate with the Model 616A will adapt this counter to make frequency measurements of up to 3000 mc and 12 gc, permitting precise frequency monitoring and calibration of many types of uhf and rf communications equipment. An additional plug-in adapter, the Model 633A Time Interval Unit, enables the counter system to make exacting time interval measurements of 10  $\mu$ secs to 10.0 secs with a resolution of 1.0  $\mu$ sec. (100 secs capacity and 0.1  $\mu$ sec resolution optional). The time interval unit extends the usefulness of the Model 616A to such applications as measurements of pulse spacing and pulse duration, relay operate and release times, and propagation delays in RLC circuits and delay lines.

The instrument's small frontal dimensions and compact form allow it to fit unobtrusively into limited bench space with other test equipment. For rack-mount installation, a dual rack adapter chassis frame (optional accessory) permits side-by-side mounting of the Model 616A Frequency Meter and a CMC Model 410A Digital Printer, an especially convenient equipment combination for such applications as frequency drift measurements, Doppler frequency recording, and digital data logging. Other manufacturers' half rack instruments may also be mounted in the Model 616A optional rack adaptor, provided that they do not exceed 10½" in height.

## OPERATING ADVANTAGES

Every feature of the Model 616A Frequency Meter has been expressly designed for utmost convenience to the operator. Controls have been reduced to a minimum. Panel markings are simple and legible. The bright seven decade in-line numeric display is easy to read even under adverse lighting conditions. Two display modes, hold-while-counting, and change-while-counting are selectable by a front panel switch. Display time is manually adjustable, and is independent of counter gate time. All displayed frequencies are indicated in kilocycles; the decimal point is automatically positioned for all settings of the function switch and gate time selector. Two panel lamps indicate the automatic cycling of the crystal oven and the opening of the count gate.

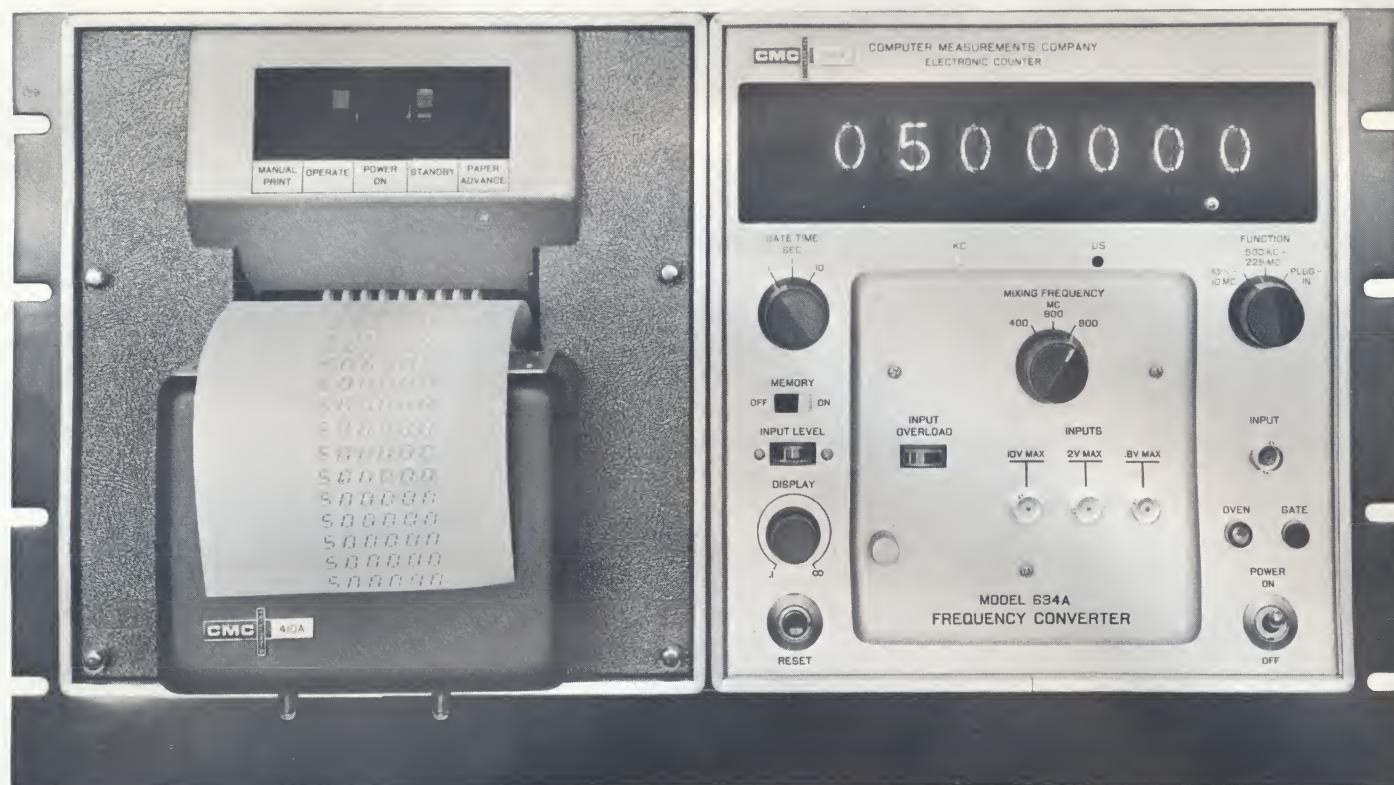
The counter input circuits have high sensitivity and are designed to accept a variety of input waveshapes of wide amplitude ranges. A color-segmented panel meter continuously monitors input signal levels for prescaled and heterodyned measurements, and indicates when there is sufficient amplitude to assure error free counting.

As an option, a digital (BCD) output connector can be provided to allow frequency measurement data to be transferred automatically or on demand directly to external equipment such as printers, tape recorders and computer systems. The precision 1 mc signal generated by the time-base crystal oscillator is brought to a coaxial connector on the rear of the counter to facilitate self-test and to serve as a standard frequency source for general laboratory use.

## DESIGN AND CONSTRUCTION

The Model 616A Frequency Meter is enclosed in a small, sturdy aluminum case with a convenient carrying handle. A protective front cover contains storage space for the counter's detachable power cord and coaxial test cable. Exterior surfaces are finished in a durable, scuff-resistant vinyl coating. Top and bottom covers are easily removed for inspection and maintenance. Integral front and rear fittings provide a means of supporting the counter assembly on the CMC rack-mount adapter, whenever a rack-mounted installation is desired. The numeric display tubes, indicators and controls are arranged for most





Model 616A Frequency Meter and Model 410A Digital Printer in Dual Rack-Mounted Panel

direct viewing and access. A recessed tilt-up stand can be extended to improve the viewing angle and bring the controls within easier reach.

The counter circuitry consists of: ac coupled input amplifiers; a 225 mc decade prescaler, which is used for measurement of frequencies above 10 mc; seven counting and display decades with storage circuitry (an eighth decade is optional); a 1 mc temperature controlled time-base crystal oscillator; time-base decade dividers; power supplies and regulators. A rear panel coaxial connector permits use of an external 1 mc time-base oscillator. For applications requiring exceptional frequency measurement accuracy, an ultra-stable 1 mc time-base oscillator (optional) can be installed in place of the standard unit. A three position function switch permits selection of (1) direct frequency measurement 10 cps to 10 mc, (2) prescaled frequency measurement 500 kc to 225 mc, or (3) extended frequency measurement through use of a plug-in frequency converter.

The Model 616A's all solid-state circuitry and efficient electrical design result in low power consumption and minimal heat generation. A small fan provides uniformly cool airflow through the interior of the counter.

Electronic components are functionally grouped on plug-in printed circuit boards to facilitate testing and maintenance. The plug-in frequency converters and time interval module, when used, are mounted through a rectangular opening in the front panel and secured with a single thumb screw. Insertion and removal are simple and rapid, requiring no tools. Where opera-

tion from 230 volt ac lines is required, changeover can be made quickly by means of a safety-locked rear panel switch.

#### RELIABILITY

The Model 616A Frequency Meter is designed to provide many years of dependable service and sustained high accuracy. The all silicon semiconductor circuitry assures reliable performance and high electrical stability over wide temperature ranges and operating conditions. The 616A's silicon semiconductor display storage circuitry is inherently superior to photoconductor memory circuits used in other makes of counters because of its resistance to temperature extremes and high humidity and its faster response time.

Thoroughly tested circuits having high efficiency and requiring relatively few components contribute further to the counter's reliability. High quality components, operated well within their safe maximum ratings, are used throughout. Built-in self-test circuitry permits rapid and positive checking of the time-base, prescaler, counting gate and digital display. The counter's superior electrical features are matched by its mechanical ruggedness and solid construction, which preserve its accuracy and reliability through frequent handling and rough usage.

#### WARRANTY

CMC, with ten years of specialized experience in the design and manufacture of electronic counters and instrument systems, backs each Model 616A Frequency Meter with a two-year free service warranty.



# MODEL 616A SPECIFICATIONS

## MEASUREMENT FUNCTIONS

Frequency.

Time Interval (with 633A plug-in).

## FREQUENCY MEASUREMENT

RANGE 1: 10 cps to 10 mc.

RANGE 2: 500 kc to 225 mc. (Prescaled)

UNITS: Kilocycles with automatically positioned decimal point in readout.

GATE TIMES: 0.1, 1.0 and 10.0 seconds.

ACCURACY:  $\pm 1$  count  $\pm$  time-base accuracy.

SELF-TEST: Counts 1 mc (or 50 mc, with Model 634D Heterodyne plug-in).

## DISPLAY

NUMBER OF DECADES: 7 decades with automatically positioned decimal point.

DISPLAY TUBES: In-line long-life biquinary display tubes.

ENUNCIATOR: Kc ( $\mu$ sec when used with Model 633A Time Interval Meter plug-in).

MEMORY: Memory switch selects (1) storage of displayed count while the next count is being accumulated, display changes only when new count changes; or (2) continuous display of counting between display periods.

TIME: Continuously adjustable from less than 0.2 second to more than 5 seconds with infinite position.

### RESOLUTION:

	Gate time: 0.1 sec	1.0 sec	10. sec
Range 1: 10 cps to 10 mc	$\pm 10$ cps	$\pm 1.0$ cps	$\pm 0.1$ cps
Range 2: 500 kc to 225 mc	$\pm 100$ cps	$\pm 10$ cps	$\pm 1.0$ cps

Extended range with Heterodyne Converter: same as Range 2.

## INDICATORS

GATE LIGHT: Lights while gate circuit is enabled.

OVEN LIGHT: Lights when oven heater is energized.

## INPUTS

### LOW FREQUENCY:

SENSITIVITY: 100 mv rms.

MAXIMUM INPUT: 10 v rms for correct reading.

OVERLOAD PROTECTION: 50 v rms without damage.

INPUT IMPEDANCE: 100,000 ohms resistance.

HIGH FREQUENCY: Same specifications as low frequency excepting:

SENSITIVITY: 100 mv at 500 kc to 200 mc.  
200 mv at 200 mc to 225 mc.

OVERLOAD PROTECTION: 100 v rms without damage (however 50 ohm termination resistor will dissipate excessive power above 10 v rms and may burn out after prolonged overload—no other damage will result).

INPUT IMPEDANCE: 50 ohms nominal resistance. Level meter indicates input level.

## TIME BASE

SOURCE: 1 mc crystal in 115 v oven.

### STABILITY AS A FUNCTION OF:

AGING: Less than  $\pm 2$  parts in  $10^7$  per month.

TEMPERATURE: Less than  $\pm 3$  parts in  $10^6$   
( $-20^\circ\text{C}$  to  $+65^\circ\text{C}$ ).

LINE VOLTAGE ( $\pm 10\%$ ): Less than  $\pm 1$  part in  $10^7$ .

SIGNAL OUTPUTS: 1 mc, (50 mc with Model 634D Heterodyne plug-in.)

RESET: Manual pushbutton or automatic.

OPERATING TEMPERATURE RANGE:  $-20^\circ\text{C}$  to  $+65^\circ\text{C}$ .

POWER REQUIREMENTS: 115/230 v ac  $\pm 10\%$ , 50-60 cps, 70 watts.

WEIGHT: 28 pounds.

## DIMENSIONS

BENCH MOUNT:  $9\frac{3}{8}$ " high x  $9\frac{5}{8}$ " wide x  $22\frac{1}{4}$ " deep.

RACK MOUNT:  $8\frac{1}{2}$ " high x  $10\frac{1}{2}$ " wide x 21" deep.

## ACCESSORIES PROVIDED

3-conductor ac power cord.

1 coaxial cable, with male

BNC connector on both ends.

Board extractor.

Extender board.

PRICE (less plug-ins)	\$2185.00
634D (3.2Gc Converter)	\$ 825.00
646A (12Gc Transfer Oscillator)	\$1550.00
633A (Time interval)	\$ 325.00
633A with option 11 (.1 $\mu$ sec resolution)	\$ 425.00

## OPTIONS

### 1. DIGITAL OUTPUT

BCD VOLTAGES:

e. 4-line binary-coded decimal (1-2-4-8).

\$75.00

Negative true logic.

"1" level: more negative than  $\mp 0.3$  volt.

"0" level: more positive than  $+6.0$  volts.

BCD SOURCE IMPEDANCE: Approximately 10 k each line.

END-OF-COUNT SIGNAL: Negative step from more positive than  $+9.0$  volts to more negative than  $+0.3$  volt.

END-OF-COUNT SOURCE IMPEDANCE: 3.3 k

### 3d. HIGH STABILITY OSCILLATOR:

$\pm 3$  parts in  $10^9$  per 24 hours.

$\pm 2$  parts in  $10^{10}$  per C°.

$\pm 5$  parts in  $10^{10}$  for  $\pm 10\%$  change in line voltage. \$325.00

### 5. ADDITIONAL DISPLAY DECADE:

b. Inline:

\$100.00

### 10. RACK-MOUNT ADAPTER:

\$ 50.00

For other special requirements contact factory.





## MODEL 634D

### 100 MHz TO 3.2 GHz HETERODYNE FREQUENCY CONVERTER



- FREQUENCY MEASUREMENTS FROM 100 MHz TO 3.2 GHz WITH MODEL 616A FREQUENCY METER
- HIGH SENSITIVITY
- PANEL METER INDICATES CORRECT TUNING
- ALL SOLID-STATE CIRCUITRY
- TWO YEAR WARRANTY

#### CHARACTERISTICS AND APPLICATIONS

The CMC Model 634D Heterodyne Frequency Converter is a plug-in electronic module which expands the frequency measurement range of the Model 616A Frequency Meter to 3.2 GHz.

Typical uses include calibration and testing of communications equipment, vhf/uhf frequency monitoring, developmental testing of receivers and transmitters, and precise measurement of signal generator, transmitter and local oscillator frequencies in radar and communication equipment through S band.

#### OPERATING ADVANTAGES

The instrument operates on the heterodyne conversion principle, mixing the unknown input frequency with a manually selected harmonic of 50 MHz. The resulting difference frequency, in the range 5 to 55 MHz, is read directly on the counter register and added to the selected harmonic frequency to obtain the true frequency of the converter input

signal. The accuracy is equal to that obtainable through direct frequency measurement. A color scaled meter indicates the correct tuning.

#### DESIGN AND CONSTRUCTION

The converter mounts in a rectangular opening in the front panel of the Model 616A Frequency Meter. Electrical power and circuit interconnections to the counter assembly are supplied through a mating connector. The converter module is secured by a single thumbscrew, making installation and removal simple and rapid.

#### WARRANTY

CMC, with more than ten years of specialized experience in the design and manufacture of high quality electronic instruments, backs each Model 634D Frequency Converter with a two year free service warranty.

#### MODEL 634D SPECIFICATIONS

##### HETERODYNE FREQUENCY MEASUREMENT:

###### INPUT SIGNAL REQUIREMENTS

- FREQUENCY RANGE: 100 MHz to 3.2 GHz.
- AMPLITUDE: 0.1 to 1 volt rms maximum.
- INPUT IMPEDANCE: Approximately 50 ohms.
- INPUT COUPLING: Dc.
- MAXIMUM INPUT WITHOUT DAMAGE: 100 mw (+20 dbm or 2.2 v rms).
- OUTPUT FREQUENCY: 5 to 55 MHz.
- OUTPUT FREQUENCY AMPLITUDE: 100 mv rms minimum.

ACCURACY:  $\pm 1$  count  $\pm$  Counter oscillator accuracy.

READOUT: Converter dial reading in gigacycles added to Counter display.

LEVEL INDICATOR: Meter indicates correct tuning.

SELF TEST (For 616A with 634D): 50 MHz (Crystal oscillator harmonic), 100 mv rms minimum. 50 ohms nominal impedance, available at rear mounted BNC connector on the 616A, for laboratory frequency standard or Counter self test source.

MOUNTING: Plugs into front panel compartment of Model 616A Frequency Meter.

WEIGHT: Approximately 5 pounds, 8 ounces.

PRICE: \$825.00.